

### 3.0 AFFECTED ENVIRONMENT

The applicant proposes to traverse approximately 19.49 km of the Stellwagen Bank NMS, which is located approximately 25 nautical mi east of Boston, MA at the eastern edge of Massachusetts Bay. Stellwagen Bank NMS occupies an area of approximately 638 square nautical mi (842 square mi), extending from Cape Ann to Cape Cod, MA. Stellwagen Bank, an important geologic feature located within the sanctuary, measures approximately 18.75 mi long and 6.25 mi wide at its widest point (NOAA 1993, cited in Earth Tech 1999). The Preferred Alternative route is located north of Stellwagen Bank, but near the southern extent of Jeffrey's Ledge, another important geologic feature, which extends northward from the sanctuary into the Gulf of Maine.

In recognition of its environmental and commercial importance, Stellwagen Bank, along with the adjacent area, was proposed to become the nation's eleventh national marine sanctuary in 1989 and was officially designated on November 4, 1992. A management plan and regulations have been developed for the sanctuary to protect its resources, while providing for compatible commercial uses of the area.

The following subsections describe the existing conditions of the environmental, social, and economic resources of and in the vicinity of the Stellwagen Bank NMS. This baseline information was compiled from available data on the sanctuary, and is substantially adopted from the "Draft Environmental Assessment: Hibernia Transatlantic Project" (Earth Tech 1999). In instances where data were not available for the sanctuary itself, data on the general region were used to characterize the resources in the sanctuary. Section 3.0 Affected Environment and Section 4.0 Environmental Consequences of Proposed Action and Alternatives are based on the best available information on the Stellwagen Bank NMS and the area in proximity to the Northern Alternative. There is a lack of specific, detailed data available on these areas. For example, there is insufficient data available to characterize the quality of the benthic habitats that lie along the two potential cable routes.

Discussed below are:

- Water resources, including water quality and sources of pollution
- Geologic resources, including sand, sediment, and mining operations
- Biological resources, including fish species, benthos, and marine mammals
- Socioeconomic resources, including recreation and commercial fishing and shipping
- Cultural and historical resources, including shipwrecks

Several resource areas are not considered in this analysis because it was determined that they were not applicable to the alternative actions. Those resources include air quality, transportation (beyond commercial fishing and shipping), hazardous materials, and safety and health. Air quality and transportation were not considered in this analysis because the presence of one ship in the area for approximately two days does not constitute a substantial increase over current levels of vessel traffic. Hazardous materials were not considered in this analysis because cable installation does not involve the use or handling of any hazardous materials. Safety and health were not considered because it is assumed that cable installation personnel are governed by company established guidelines for at-sea operations and installation of cable.

### **3.1 WATER RESOURCES**

The waters of the Stellwagen Bank NMS are characteristic of the waters of Massachusetts Bay and are fully marine, with salinity averaging approximately 32 parts per thousand (ppt). Water temperatures range from near freezing in late winter months to a high of approximately 63 degrees (°) Fahrenheit (F) in late summer. Sediment load varies seasonally, depending on the influx of freshwater, as well as tropical storms. Water quality in the project area and sources of pollution are discussed below.

#### **3.1.1 Water Quality**

Studies indicate that there are detectable levels of water pollution throughout Massachusetts Bay, including the areas proposed as the locations of both alternative routes. Detectable pollution includes elevated levels of metals, petroleum products, and polychlorinated biphenyls (PCBs) (Pett and McKay 1990, cited in Earth Tech 1999). Research is insufficient to support determination of the specific distribution of pollutants or their effects on natural resources in Massachusetts Bay, or in the Stellwagen Bank NMS in particular. The following information, taken from various sources included on the Stellwagen Bank NMS Web page (USGS/NOAA 1996, cited in Earth Tech 1999), summarizes what is known about contaminant levels as they may affect water quality along the proposed Hibernia cable route.

Several studies have sampled levels of water contaminants in proximity to the Stellwagen Bank NMS, and compared those levels with the U.S. Environmental Protection Agency's (EPA) acute and chronic water quality criteria for marine waters and with the maximum acceptable toxicant concentrations (MATC). For reference, the MATC generally is the same or higher than the corresponding EPA marine chronic value. Studies conducted in 1973 and 1974 identified levels of copper, lead, and mercury in excess of the EPA marine chronic criteria for those contaminants, but in general not in excess of the MATC. A more recent study, conducted in 1992 by Battelle Ocean Sciences, analyzed the waters of Massachusetts Bay for 16 polycyclic hydrocarbon (PAH) compounds, PCBs, selected pesticides, and 8 trace metals. That study identified no exceedances of EPA criteria or MATCs. A 1987 Battelle Ocean Sciences study of the waters of Stellwagen Basin showed levels of metals and PAHs below the water quality criteria (USGS/NOAA 1996, cited in Earth Tech 1999).

#### **3.1.2 Sources of Pollution**

The Gulf of Maine, and in particular the Massachusetts Bay area, including the Stellwagen Bank NMS, is subject to anthropogenic influxes of inorganic and organic contaminants from a variety of point and non-point sources (USGS/NOAA 1996, cited in Earth Tech 1999). Primary sources of pollution include wastewater discharges and combined sewer overflow, riverine discharge (particularly from the Merrimack River), active dredge disposal sites, and atmospheric deposition. Waste disposal and active dredge disposal sites contribute to pollution levels in their immediate areas, and have a lesser potential to contribute to water contamination within the Stellwagen Bank NMS through remobilization of sediments (USGS/NOAA 1996 cited in Earth Tech 1999). Table 3-1 provides a summary of the categories of potential sources of pollutants in the region.

##### ***Point Sources***

Massachusetts Bay receives wastewater discharges from 13 municipal wastewater treatment plants (Maciolek and Menzie 1990, cited in Earth Tech 1999). The Massachusetts Water Resources Authority is completing construction of the Deer Island Ocean Outfall, which will discharge treated wastewater into

coastal waters 16.4 mi from the western boundary of the Stellwagen Bank NMS. It is anticipated that new treatment technologies to be used at that facility will remove 90 percent of most contaminants through secondary treatment, thereby decreasing current levels of such wastewater contaminants as metals and nutrients (Maciolek and Menzie 1990, cited in Earth Tech 1999). In addition, industrial discharges permitted under the National Pollutant Discharge Elimination System may result in the discharge of elevated levels of contaminants into ocean waters. Effluents from combined sewer overflows, when stormwater discharges combine with wastewater discharges, can contribute petroleum compounds, metals, PAHs, and PCBs to receiving waters (Pett and McKay 1990, cited in Earth Tech 1999).

**Table 3-1: Potential Sources of Water and Sediment Contamination in the Gulf of Maine, Particularly in the Stellwagen Bank Area.**

<b>POINT SOURCES</b>
<b>Discharges from wastewater treatment plants (WWTP)</b> <ul style="list-style-type: none"> <li>• 13 in area</li> <li>• Deer Island Ocean Outfall, Boston, Massachusetts, to come into use 16.4 mi from the western boundary of the Stellwagen Bank NMS</li> </ul> <b>Industrial discharges</b> (some in combination with WWTPs) <b>Combined sewer overflow</b> (stormwater and sewage) <b>Massachusetts Bay Disposal Site</b> (an active dredge disposal area since 1977) <b>Former Boston Foul Site or Industrial Waste Site</b> <ul style="list-style-type: none"> <li>• Active from 1950s through 1977</li> <li>• Undocumented dumping of hazardous and non-hazardous wastes</li> <li>• Included low-level radioactive waste site from 1952 to 1960</li> </ul>
<b>NON-POINT SOURCES</b>
<b>River Discharges into northern Gulf of Maine, especially Merrimack River</b> <b>Discharges from boat traffic</b> <b>Atmospheric deposition</b>

Source: Maciolek and Menzie 1990; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999.

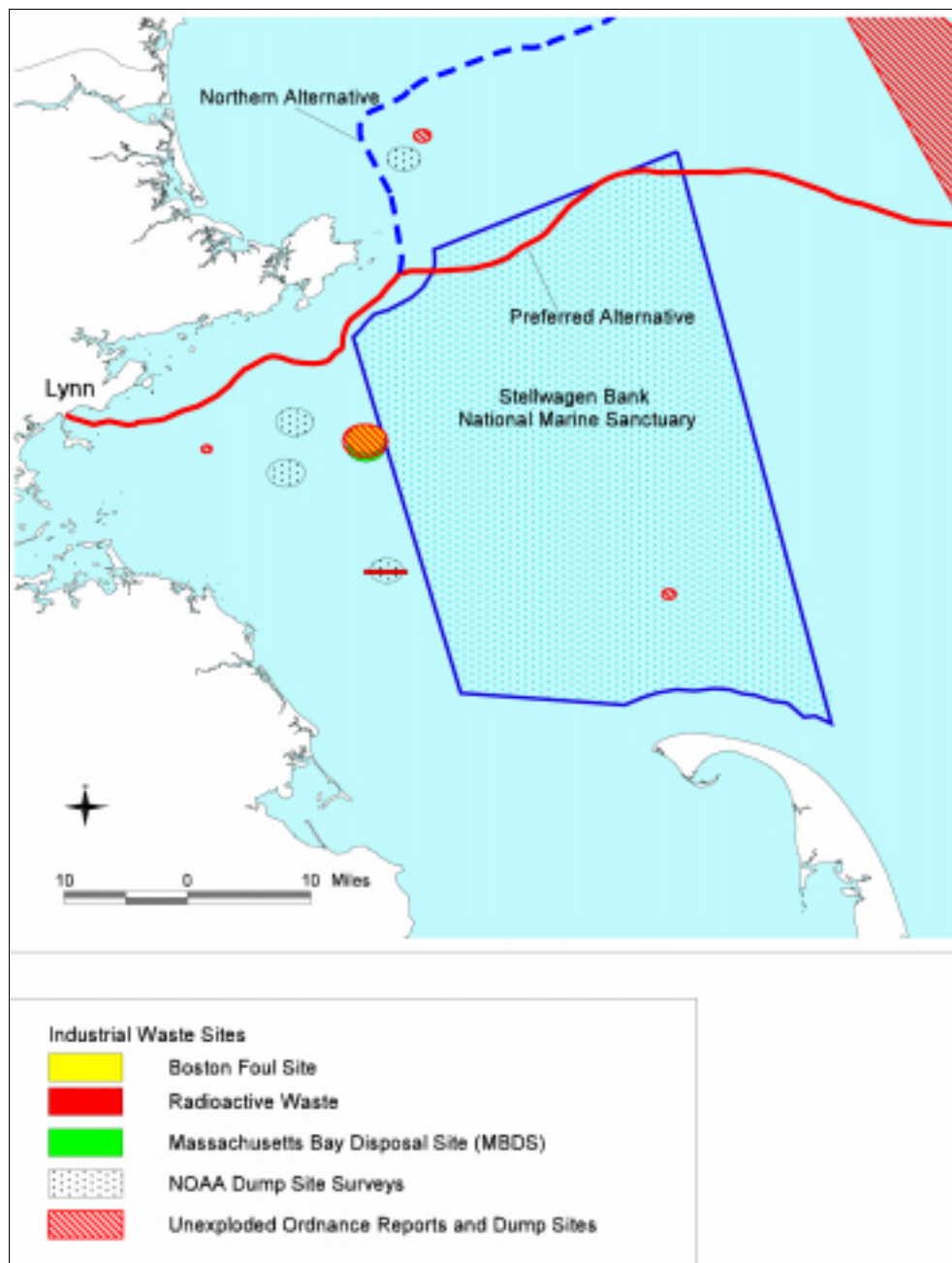
Several areas of Massachusetts Bay, in close proximity to the northwest corner of the Stellwagen Bank NMS, historically have been used for disposal of low-level radioactive waste and toxic waste and, historically to the present, for disposal of dredge spoil (see Figure 3-1). Since the 1940s, the Stellwagen Basin area, just to the west of the Stellwagen Bank NMS, has been used to dispose of low-level radioactive waste, explosives, toxics and other industrial waste, construction debris, and dredged material. The Stellwagen Basin area has been used for disposal because of its proximity to Boston, its depth (60 to 100 m), and its depositional nature (Pett and McKay 1990, cited in Earth Tech 1999). Much of that early use was unregulated.

From 1952 to 1960 the area known as the Boston Foul Site or Industrial Waste Site was used for the disposal of low-level radioactive waste. Radioactive material, primarily from hospitals and research facilities, was encased in reinforced concrete designed to resist corrosion by seawater. Testing of the area performed by EPA in 1981 and 1982 indicated that the levels of radioactivity in commercial fish species and in sediments were at or below ambient levels, indicating that the area was not a significant source of radioactivity (Pett and McKay 1990, cited in Earth Tech 1999). There is little documentation related to the dumping of toxic wastes at the Boston Foul Site, which was closed in 1977. However, there is evidence that containers of waste are present throughout the area. It is likely that contaminants include halogenated organic compounds and heavy metals, among other substances (Pett and McKay 1990, cited

in Earth Tech 1999). In 1970, the U.S. Food and Drug Administration (FDA) issued a warning notice about the harvesting of fish species and shellfish in the contaminated area, and the area has been closed to fishing for surf clams and quahogs by NMFS since 1980 (Dorsey 1990, cited in Earth Tech 1999).

The Massachusetts Bay Disposal Site (MBDS) is a circular area, 3.7 km in diameter, located 22.23 km southeast of Gales Point. The MBDS has been an active dredge disposal area since 1977, although its location, which overlaps the Boston Foul Site, has changed slightly over the years. The MBDS receives dredge spoil from harbors and waterways along the entire coast of Massachusetts Bay, but predominantly from Boston Harbor (NOAA 1993, cited in Earth Tech 1999). Likely contaminants include metals and

**Figure 3-1: Location of Disposal Areas in Massachusetts Bay (USGS, 2000)**



PCBs. The area is one of the most active dredge disposal sites in New England (Maciolak and Menzie 1990, cited in Earth Tech 1999). It is projected that over the next 50 to 100 years, the area will receive from 11.7 to 23.3 million cubic yards of dredge soil. That quantity of material could raise the seabed by as much as 0.8 to 1.6 m, if evenly dispersed. Recent monitoring studies that included sampling at the active disposal buoy determined that disposal of dredged material at MBDS is not impeding benthic recolonization (Pett and McKay 1990, cited in Earth Tech 1999).

### ***Non-Point Sources***

Non-point sources of pollutants also may have a significant impact on Massachusetts Bay. River discharges into the Gulf of Maine can contribute nutrients and toxics to coastal waters. In particular, the Merrimack River has a freshwater plume that reaches around Cape Ann and can be a significant source of metals, PAHs and PCBs (Maciolak and Menzie 1990, cited in Earth Tech 1999). Non-point sources of pollutants also include river discharges into the northern Gulf of Maine from the Piscataqua, Saco, Androscoggin and Kennebec rivers. Atmospheric deposition, particularly of metals and nutrients, can be a significant source of pollution of coastal waters and can carry pollutants from distant sources. Finally, discharges from boat traffic, including discharges of sanitary waste and bilge water, fuel oil spills, and disposal of general debris, can contribute nutrients, petroleum compounds, and metals to the water and sediments.

## **3.2 GEOLOGIC RESOURCES**

Stellwagen Bank, as well as similar submerged banks along the northeastern coast of the U.S., were created by advances and retreats of glaciers. Banks and ridges in the Gulf of Maine are described as having an underlying layer of gravel and boulders. Gravel and sand are typical substrates in the near-shore areas (Hassol 1987; Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999). Four sediment types have been described for the Gulf of Maine region: gravel, sand, silt-sand, and silt-clay (Wigley 1968, cited in Earth Tech 1999). Table 3-2 shows the percentages of sediment types traversed by each alternative route.

**Table 3-2: Percentages of Bottom Types Along the Alternative Routes**

<b>Bottom Type</b>	<b>Preferred Alternative (within SBNMS)</b>	<b>Northern Alternative</b>
Gravel (mixed coarse)	14%	5%
Sand	35%	10%
Mud	46%	55%
Mud (Silt-Clay)	5%	30%
<b>Totals</b>	<b>100%</b>	<b>100%</b>

Source: Seafloor Surveys International, Inc. 1999

Stellwagen Bank has surficial sediments that are primarily sands, flanked to the east by gravels and gravelly-sands. Minor quantities of gravel are associated with sand on Stellwagen Bank. Bottom sediments in the area of Stellwagen Bank NMS have been described as mostly sand, except for some patches of gravel on the eastern portion of the bank. It also has been noted that sand-silt and silt-clay sediments are found in areas adjacent to Stellwagen Bank (Pett and McKay 1990, cited in Earth Tech 1999).

Jeffrey's Ledge, which lies north of Stellwagen Bank, is composed primarily of gravels or gravelly-sand, flanked by a sandy area to the southeast. No specific information is available about the entire area around the northern perimeter of Jeffrey's Ledge; therefore, information must be inferred from what is known about nearby areas. The nearby areas are characterized by unconsolidated marine sediments, similar to those in the areas east of Stellwagen Bank (Earth Tech 1999).

Pigeon Hill is a glacially eroded off-shore pinnacle, located on the south-central portion of Jeffrey's Ledge, 37 km from Cape Ann, MA. The knoll rises from a mud bottom 125 m deep to within 30 m of the surface. The area is described as relatively pristine and in the midst of a commercial fishing area. The benthic communities in the area are composed primarily of northern species that can tolerate significant disturbance. In addition, there are observable and quantifiable differences among communities of horizontal and vertical substrata, as well as with depth (Hulbert et al. 1982, cited in Earth Tech 1999).

Areas between Stellwagen Bank and Jeffrey's Ledge are covered with sand mixed with some gravel. To the east of Stellwagen Bank NMS, extending into Wilkinson's Basin, there is a more depositional environment, with a higher percentage of silts within the sandy substrates (NOAA 1993, cited in Earth Tech 1999). The following sections describe sediment contaminants, mining of sand and gravel, and offshore oil and gas activity in the vicinity of the Stellwagen Bank NMS.

### ***Sediment Contaminants***

The concentrations of contaminants within sediments, as well as their bioavailability, vary according to the composition and particle size of the sediment. Depositional areas, such as Stellwagen Basin, tend to have higher concentrations of contaminants than higher-energy areas, such as the surfaces of Stellwagen Bank. Methods of assessing the potential effects of contaminants in sediment must take those various factors into consideration. One index EPA commonly uses is the Apparent Effects Threshold (AET), which is a correlative index defined as the concentration of contaminants in sediment above which an adverse biological effect always is observed statistically (USGS/NOAA 1996, cited in Earth Tech 1999).

A 1976 study of concentrations of metals and PCBs in sediments in Massachusetts Bay identified slightly elevated concentrations of the metals chromium, mercury, nickel, lead, and zinc, particularly in the depositional Stellwagen Basin; however, few measurements exceeded the AET values for lead and zinc, and there were no exceedances for cadmium, chromium, or PCBs. A 1979 study of concentrations of PAHs in Massachusetts Bay identified levels below the AET values. Other studies confirm a low level of contamination of sediment compared with levels that exceed toxicity criteria. Significantly elevated levels of metals, PCBs, and PAHs have been found within and near the MBDS; those findings are within the range of levels that are likely to cause adverse effects on marine biota (Pett and McKay 1990, cited in Earth Tech 1999).

In summary, on the basis of limited data, the majority of sediments in Massachusetts Bay, including those within the Stellwagen Bank NMS, are impacted by metals, PAHs, PCBs, and pesticides at levels that do not exceed of marine toxicity criteria established by EPA. The areas of Stellwagen Basin near the MBDS and the Boston Foul Site have significantly contaminated sediments that are more likely than other sediments in Massachusetts Bay to have an adverse effect on ocean life. However, few, if any, studies have measured levels of contaminants in marine biota from the area to assess potential toxic effects (Earth Tech 1999).

### ***Mining of Sand and Gravel***

Sand and gravel are used extensively in the construction industry and also in beach nourishment projects. In recent years, use and demand for sand and gravel resources have increased in the Boston metropolitan area. Several factors, including proximity to Boston, have combined to make off-shore mining of sand

and gravel an attractive alternative to land mining. However, mining of sand and gravel in the Stellwagen Bank NMS is prohibited expressly by statute (Public Law 102-587, subtitle B, Section 2202, cited in Earth Tech 1999).

### *Offshore Oil and Gas Activity*

Stellwagen Bank is located within the northwest section of the North Atlantic Planning Area of the Atlantic Outer Continental Shelf (OCS) Region. Within the planning area, the Gulf of Maine has been identified as an area of hydrocarbon potential. However, no OCS oil or gas lease sales have been made in the area of the Stellwagen Bank NMS (Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999).

## **3.3 BIOLOGICAL RESOURCES**

The following discussion of biological resources focuses on areas of unconsolidated sediment, since the site of the project has been selected to avoid rocky and hard-bottom areas to facilitate burial of the cable. In the case of some of the following resource descriptions, information about the exact area of the cable route is not readily available. Much more information about Stellwagen Bank and nearby Georges Bank is available. Some of the descriptions therefore may present information that relates to widespread distribution or may have been inferred for the project area.

Biological resources are presented in six categories, corresponding to the type of organisms described. Section 3.3.1 discusses fish species and essential fish habitat (EFH) of the region. Section 3.3.2 describes benthic communities, including vegetation and animals, that frequent the ocean floor in the vicinity of the Stellwagen Bank NMS. Section 3.3.3 describes the marine mammals that have been found in the area. Sections 3.3.4 and 3.3.5, respectively, describe the marine reptiles and birds of the area. Section 3.3.6 describes the plankton (both phyto- and zooplankton) found in the Stellwagen Bank NMS area.

Practically every northwest Atlantic threatened or endangered species of sea turtle and marine mammal has been documented somewhere along the proposed cable-laying route (Kurkul 2000). Threatened and endangered species, as defined and protected under the Endangered Species Act (ESA), 16 U.S.C. 1531 *et seq.*, are discussed in each section as relevant. Table 3-3 presents a summary of the threatened and endangered species found in the vicinity of the Stellwagen Bank NMS.

**Table 3-3: Threatened and Endangered Species Found in the Vicinity of the Stellwagen Bank NMS**

COMMON NAME	SCIENTIFIC NAME	LISTED STATUS
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
Northern right whale	<i>Eubalaena glacialis</i>	Endangered
Fin whale	<i>Balaenoptera physalus</i>	Endangered
Sei whale	<i>Balaenoptera borealis</i>	Endangered
Blue whale	<i>Balaenoptera musculus</i>	Endangered
Loggerhead turtle	<i>Caretta</i>	Threatened
Green Sea turtle	<i>Chelonia mydas</i>	Threatened
Atlantic or Kemp's ridley turtle	<i>Lepidochelys kemp</i>	Endangered
Leatherback turtle	<i>Dermochelys oriacea</i>	Endangered
Roseate tern	<i>Sterna dougallii</i>	Endangered

Source: Earth Tech 1999



### 3.3.1 Fish Species and Habitat

At least 141 species of fish, many of which commonly are found within the Stellwagen Bank NMS (see Appendix E), have been documented in Massachusetts Bay. The geographic and thermal transition zone that occurs at Cape Cod, which separates the Gulf of Maine from the Mid-Atlantic region, supports such extensive diversity of species. The transition zone provides the variety of habitats essential to the life cycles of many fish species (see tables 3-4 and 3-5). The Gulf of Maine primarily supports northern, non-migratory species. Many of the pelagic species, such as herring, tuna, and menhaden, show seasonal migratory movement in conjunction with changes in water temperature. Seasonal movements of most of the demersal species, such as flounder, are confined to changes in the Gulf of Maine. The greatest diversity of fish species is usually found in the autumn (Earth Tech 2000b).

**Table 3-4: Summary of Essential Fish Habitat (EFH) of Commercially Important Species Present in Northern Stellwagen Bank National Marine Sanctuary**

Common Name	Scientific Name	Life Stages Present			
		Eggs	Larvae	Juveniles	Adults
Atlantic cod	<i>Gadus morhua</i>	X	X	X	X
Haddock	<i>Melanogrammus aeglefinus</i>	X	X	X	X
Pollock	<i>Pollachius virens</i>	X	X	X	X
Red hake	<i>Urophycis chuss</i>	X	X	X	X
White hake	<i>Urophycis tenuis</i>	X	X	X	X
Silver hake (whiting)	<i>Merluccius bilinearis</i>	X	X	X	X
Redfish	<i>Sebastes faciatius</i>	N/A	X	X	X
Witch flounder	<i>Glyptocephalus cynoglossus</i>	X	X	X	X
Winter flounder	<i>Pleuronectes americanus</i>	X	X	X	X
Yellowtail flounder	<i>Pleuronectes ferruginea</i>	X	X	X	X
Windowpane flounder	<i>Scopthalmus aquosus</i>		X		
American plaice	<i>Hippoglossoides platessoides</i>	X	X	X	X
Ocean pout	<i>Macrozoarces americanus</i>	X	X	X	X
Atlantic halibut	<i>Hippoglossus hippoglossus</i>	X	X	X	X
Atlantic sea scallop	<i>Placopecten magellanicus</i>	X	X	X	X
Atlantic sea herring	<i>Clupea harengus</i>	X	X	X	X
Monkfish	<i>Lophius americanus</i>	X	X	X	X
Long-finned squid	<i>Loligo pealei</i>	N/A	N/A		X
Short-finned squid	<i>Illex illecebrosus</i>	N/A	N/A		X
Atlantic mackerel	<i>Scomber scombrus</i>	X	X	X	X
Spiny dogfish	<i>Squalus acanthias</i>	N/A	N/A	X	X
Blue shark	<i>Prionace glauca</i>				X
Porbeagle shark	<i>Lamna nasus</i>				X
Bluefin tuna	<i>Thunnus thynnus</i>			X	X

Source: NOAA 1999. Guide to Essential Fish Habitat Designations in the Northeastern United States. Volume II: Massachusetts and Rhode Island. NMFS, cited in Earth Tech 2000b.



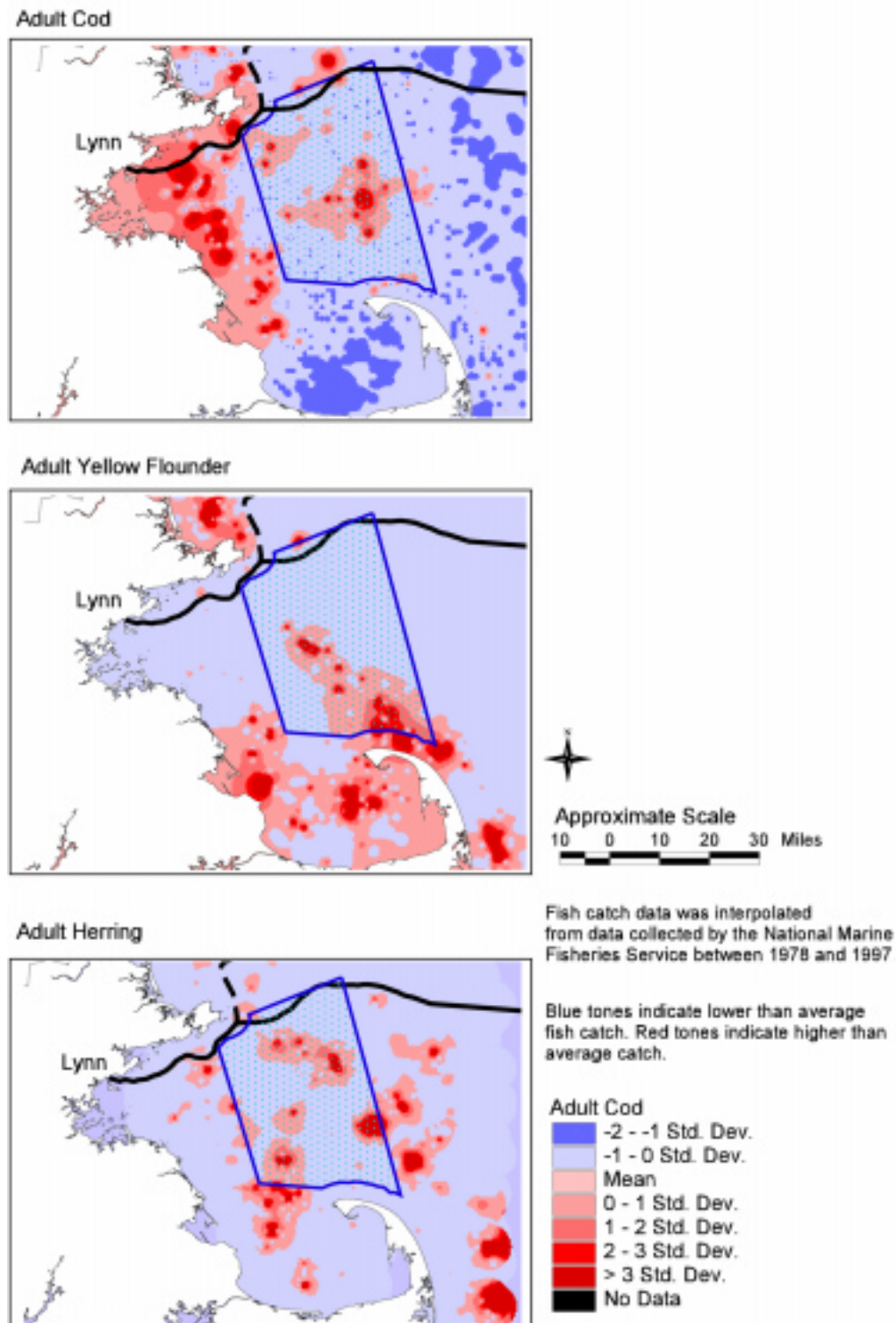
**Table 3-5: Summary of EFH Present Within the Northern Alternate Route**

Common Name	Scientific Name	Life Stages Present			
		Eggs	Larvae	Juveniles	Adults
Atlantic cod	<i>Gadus morhua</i>	X	X	X	X
Haddock	<i>Melanogrammus aeglefinus</i>	X		X	X
Pollock	<i>Pollachius virens</i>	X	X	X	X
Whiting	<i>Merluccius bilinearis</i>	X	X	X	X
Red hake	<i>Urophycis chuss</i>	X	X	X	X
White hake	<i>Urophycis tenuis</i>	X	X	X	X
Redfish	<i>Sebastes faciatius</i>	N/A	X	X	X
Witch flounder	<i>Glyptocephalus cynoglossus</i>	X	X	X	X
Winter flounder	<i>Pleuronectes americanus</i>	X	X	X	X
Yellowtail flounder	<i>Pleuronectes ferruginea</i>	X			
American plaice	<i>Hippoglossoides platessoides</i>	X		X	X
Ocean pout	<i>Macrozoarces americanus</i>	X	X	X	X
Atlantic halibut	<i>Hippoglossus hippoglossus</i>	X	X	X	X
Atlantic sea scallop	<i>Placopecten magellanicus</i>	X	X	X	X
Atlantic sea herring	<i>Clupea harengus</i>	X	X	X	X
Monkfish	<i>Lophius americanus</i>	X	X	X	X
Bluefish	<i>Pomatomus saltatrix</i>				
Long-finned squid	<i>Loligo pealei</i>	N/A	N/A		
Short-finned squid	<i>Illex illecebrosus</i>	N/A	N/A		X
Spiny dogfish	<i>Squalus acanthias</i>	N/A	N/A	X	X
Bluefin tuna	<i>Thunnus thynnus</i>				X
Porbeagle shark	<i>Lamna nasus</i>				X
Blue shark	<i>Prionace glauca</i>				X

Source: NMES 1999. Guide to Essential Fish Habitat Designations in the Northeastern United States. Volume II: Massachusetts and Rhode Island. Cited in Earth Tech 2000b.

Several of the fish species use the area for spawning or seasonal feeding. Many species, including cod, haddock, silver hake, American plaice, and witch flounder, breed on Stellwagen Bank, but not in the deeper waters of the Gulf of Maine. The American sand lance spawns at Stellwagen Bank and forms an important link in the trophic chain from the zooplankton, on which the sand lance preys, to its predators, including cod, haddock, silver hake, yellowtail flounder, striped bass, bluefish, and several species of whale. Other species known to spawn in the Gulf of Maine include fourbeard rockling (April through June), witch flounder (March through June), Atlantic herring (August through October), and Atlantic cod (December through April). Massachusetts Bay is the primary spawning ground of the only known species of pollock in the northwest Atlantic (October through March) (Earth Tech 1999).

The Gulf of Maine is one of the most heavily fished areas in the United States. Therefore, commercial fishing is an important industry in the region (see Section 3.5, Socioeconomic Resources). More than 20 species of fish found in the area are important commercially and many of those species are described below (USGS/NOAA 1996, cited in Earth Tech 1999). Major areas of fish species habitat in Massachusetts Bay are shown in Figure 3-2.

**Figure 3-2: Massachusetts Bay Fish Species Habitat (USGS 2000)**

The Atlantic cod is a demersal to midwater fish, ranging from surf to 366 m (Pett and McKay 1990, cited in Earth Tech 1999). Cod can grow to 90 kilograms (kg); however, in the area, they generally do not grow larger than 7 kg or 8 kg. Cod can reach an age of 22 years. They prefer rocky or pebbly bottoms. These

fish forage for clams, crabs, shrimp, worms, squid, and many fish species; larger cod may eat skates, flatfish, and even sculpin and searobins. Cod are cool-water fish, and regional abundance varies seasonally (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). These fish spawn primarily during the winter in the Gulf of Maine region.

Haddock are bottom-feeders, foraging for crabs, worms, clams, and sometimes fish (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). Haddock are found on sand and gravel bottoms, in waters varying in depth from 45 to 135 m (Pett and McKay 1990, cited in Earth Tech 1999). These fish prefer cool waters and, in the summer and fall, migrate northeastward from most locations. Haddock can reach an age of 18 years and obtain 122 cm in length. Haddock always have been a highly prized commercial species; small haddock may be known more familiarly as “scrod.” In the 1970s, the Georges Bank haddock fishery collapsed; currently, it has not recovered completely (Avarovitz and Grosslein, 1987, cited in Earth Tech 1999).

Pollock generally are found in large, fast-swimming schools, frequenting almost all depths and feeding on large zooplankton and other fish species. They generally are 4 to 7 kg in weight, but have been known to exceed 30 kg. Pollock prefer cool water and rough bottoms; they often are found near wrecks. These fish migrate seasonally to follow cooler waters (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Three species of hake are commercially important in New England regional fisheries: red hake, white hake, and silver hake. Red hake are generally 50 cm in length and 2 kg in weight (Avarovitz and Grosslein 1987, cited in Earth Tech 1999), but can reach a maximum of 75 cm in length (Brown 1987, cited in Earth Tech 1999). They migrate seasonally according to water temperature. Red hake can be found from the Gulf of St. Lawrence to North Carolina. Juveniles live in empty scallop shells; presumably, an instinctive protective measure. These fish are palatable when fresh, but do not keep well; their usefulness to a directed commercial fishery therefore is limited. Red hake often are confused with white hake, especially as juveniles. Both species occur throughout the region, although white hake generally are found farther to the north.

Silver hake also are known as “whiting.” These fish prefer warmer waters than do most of the other members of the cod family, and range from the Newfoundland Banks to South Carolina (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). These fish are voracious feeders that range throughout the water column, preying primarily upon other fish species and squid. These fish are important commercial fishery resources for the New England region (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). Silver hake reach a maximum length of 66 cm; females of the species can live to 12 years of age while males live only for some 6 years. Silver hake spawn principally in July and August in the Gulf of Maine area.

Redfish, also known as “ocean perch,” generally are found in deep waters, where they remain on the bottom during the day. At night, they feed near the surface. Redfish grow extremely slowly; it often takes 10 years for an individual to reach a length of 20 cm. Such a slow growth rate coupled with the fact that they are taken easily by trawlers while on the bottom during the day makes them especially vulnerable to overfishing (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Three species of flounder are considered to be of commercial importance in New England fisheries: winter flounder, witch flounder, and yellowtail flounder. Winter flounder are also known as “blackback,” and are sought after for sport fishing, as well as commercial fishing. These fish range from Labrador to Georgia. They can grow to 62 cm in length and attain an age of 12 years. They are sedentary fish, preferring soft, muddy or sandy bottoms. In winter, coastal populations move into very shallow or estuarine waters to spawn. Winter flounder feed during the day, primarily on small invertebrates (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Witch flounder are most common along the continental shelf of Georges Bank in waters 300 to 450 m deep. They are demersal, preferring fine, soft ground between rocky patches. These fish also are known

as “gray sole” and feed primarily on small invertebrates, rarely eating other fish species (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Yellowtail flounder can reach 65 cm in length; however, most individuals caught currently are less than 50 cm long. As adults, they are found distributed widely in waters 10 m to 100 m deep, on sandy or sandy-mud bottoms; they avoid soft mud or hard, rocky bottoms (Avarovitz and Grosslein 1987; Pett and McKay 1990, cited in Earth Tech 1999). Juveniles prefer rough bottoms, which offer more protection than other environments (Avarovitz and Grosslein, 1987, cited in Earth Tech 1999). Yellowtail flounder can reach a maximum age of some 14 years. Heavy fishing has had a strong affect on spawning populations of yellowtail flounder (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

American plaice are bottom-dwelling fish that have a small midwater foraging range (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). They prefer sand-mud bottoms and are concentrated in the Gulf of Maine, from 150 to 250 m deep (Pett and McKay 1990, cited in Earth Tech 1999). They are not migratory and regional populations can be distinguished physiologically from one another. American plaice forage for a variety of invertebrates and rarely eat other fish species. Juvenile plaice are preyed upon by many species, but adults are prey only for halibut, dogfish, and other large predators. This fish prefers cold waters (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Atlantic sea herring are pelagic fish found widely distributed throughout the Gulf of Maine (Avarovitz and Grosslein 1987; Pett and McKay 1990, cited in Earth Tech 1999). Herring are migratory, but maintain individual populations in certain areas. They range from polar ice in Greenland to Cape Hatteras. They can grow to 44 cm, and live to an age of 18 years. These fish feed on copepods, euphausiids, mollusk larvae, and other fish species eggs, primarily in the upper water column (Avarovitz and Grosslein 1987, Pett and McKay 1990, cited in Earth Tech 1999). They in turn are preyed upon by many fish species, as well as seabirds, porpoises, and whales. In the 1960s and 1970s, the herring population of Georges Bank was decimated by intense fishing activity, and the fishery collapsed altogether in 1977. Because of the tendency of these fish to maintain discreet populations, there has been no appreciable increase in herring populations on Georges Bank since that collapse (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

The Atlantic mackerel is a pelagic fish of commercial importance that moves inshore in the Gulf of Maine region during spring (Pett and McKay 1990, cited in Earth Tech 1999). These fish range from Labrador to North Carolina. Mackerel can reach an age of 18 to 20 years and a maximum length of 56 cm. In spring and early summer, mackerel spawn in the Gulf of Maine region.

Spiny dogfish are voracious predators of almost any species smaller than themselves and therefore have a significant effect on the populations of mackerel, herring, scup, cod, silver hake, and haddock. Spiny dogfish generally are 1 m in length and have no significant natural enemies (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). They are abundant in the Gulf of Maine area, where they remain year-round, avoiding warm shallows. Spiny dogfish can live for 30 to 40 years but have a low reproductive potential. Females do not reach maturity until age 14 and generally do not produce more than four to six offspring in each two-year gestation period (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Atlantic bluefin tuna are important recreational and commercial fish in the Stellwagen Bank area (Jarvis 1990; Terkla 1990, cited in Earth Tech 1999). Atlantic bluefin are pelagic fish that are present in the Gulf of Maine from June to October (Pett and McKay 1990, cited in Earth Tech 1999).

American sand lances are eel-like fish that grow to, on average, 25 cm in length. They prey primarily on copepods, but also eat other fish species eggs and larvae. In turn, they are important in the diet of bluefish, cod, pollock, spiny dogfish, silver hake, and whales. Sand lances rely on sandy bottoms for habitat and, therefore, are found in somewhat patchy distributions. They do not migrate, and their geographic distributions do not vary significantly by season (Azarovitz and Grosslein 1987, cited in Earth Tech 1999).

Sculpins are not an important commercial species and are used by fishermen only for lobster bait. They are demersal fish, found on all types of bottoms (Avarovitz and Grosslein 1987, cited in Earth Tech 1999), often partially buried in bottom sediment. They play an important ecological role since they eat almost any bottom-dweller they encounter, including most invertebrates, other fish species' eggs, and juvenile fish of many important species. Sculpins are also an important forage species for carnivorous fish. They concentrate in the Great South Channel during fall.

Butterfish are schooling pelagic fish that migrate seasonally within the range from Georges Bank to Cape Hatteras. They are an important ecological link in the food web; butterfish eat jellyfish, copepods, and sometimes other small fish species and are themselves preyed upon heavily by squid, bluefish, and others. Commercially, they are fished for use in fish meal and as bait and, to a minor extent, as a foodfish. Most butterfish spawn in inshore waters (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Bluefish are a favorite of sport and commercial fishermen alike, but the recreational catch exceeds the commercial catch largely because bluefish have replaced stocks of striped bass, which currently are very low, as the main recreational fishery of the Middle Atlantic. These fish are voracious, fast-swimming predators that feed throughout the water column on fish species only slightly smaller than themselves. Bluefish have a wide range of distribution, but generally prefer warmer waters and migrate seasonally to follow water temperature (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). They are fast-growing and can live for 14 years; they reach a maximum length of 114 cm.

Scup are an important commercial and recreational fish species, ranging from south of Georges Bank to Cape Hatteras. Scup are bottom-feeders and forage for small invertebrates. In late spring and summer, these fish move to inshore waters where they spawn (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Cusk are members of the cod family that prefer hard, rocky bottoms and are found in deep, cold waters. These fish are solitary and are not extremely abundant throughout the Gulf of Maine area. Although they are harvested commercially, lack of abundance limits their usefulness for a directed fishery (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

### 3.3.2 Benthic Communities

The benthic infauna serve as an important food source for various life stages of the fish species that occur in the Stellwagen Bank NMS area. Benthic communities in the vicinity of the sanctuary have not been well characterized. Because data are limited, characterization has been inferred from the data collected during several evaluations of benthic communities conducted in the Georges Bank and the Gulf of Maine region. Data from studies of the structure of the benthic community performed in Massachusetts Bay within or near the boundary of the Stellwagen Bank NMS give some limited, but site-specific, information (Pett and McKay 1990; NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999). Blake and others (1998) presented the following benthic information from farfield research stations, which are research stations farther from shore, located in the vicinity of the project.

Conditions at most of the farfield stations appeared to be more stable, in terms of faunal communities, from year to year than those at the nearfield and midfield stations, since the farfield stations were at a distance from Boston Harbor and the influence of nearshore sediment transport processes. One station showed an affinity to the nearshore environment, is sandy, and is dominated by the *Spionid polychaetes*, *Prionospio steenstrupi*, *Spio limicola*, and *Dipolydora socialis*. Other species that were characteristic of the assemblage included the bivalves *Nucula delphinodonta* and *Thyasira gouldii*, the amphipod *Harpinia propinqua*, and the large burrowing polychaete *Aglaophamus circinata*. A second group of farfield stations near Stellwagen Basin were located in 62 to 87 m of water. These stations were silty with only moderate amounts of sand. The assemblage was characterized by six polychaetes and one oligochaete: *Chaetozone setosa*, *Aricidea quadrilobata*, *Levinsenia gracilis*, *Anobothrus gracilis*,

*Mediomastus californiensis*, *Galathowenia oculata* and *Tubificoides apectinatus* (Blake 1998, cited in Earth Tech 1999).

Analysis of the species present at the research stations indicates that the benthic offshore environment in Massachusetts Bay differs consistently from the nearshore environment. Further, population densities at those stations located farther offshore than others were less variable and tended to be lower than those at the nearshore stations (Blake 1998, cited in Earth Tech 1999).

Table 3-6 presents phyla that are representative of the gravel community in the Gulf of Maine. They are: Porifera, Coelenterata, Arthropoda, Annelida, Mollusca, Echinodermata, and Chordata. On offshore banks made up of sand sediments in the Gulf of Maine, the following groups are dominant, as presented in Table 3-7: Crustacea, Annelida, Mollusca and Echinodermata. Table 3-8 shows phyla that are representative of the sand-silt benthic communities (sand-silt containing more than 25 percent organic matter). They are: Coelenterata, Arthropoda (Crustacea), Annelida, Mollusca, and Echinodermata. Phyla representative of silt-clay benthic communities found in deepwater basins in the Gulf of Maine include Arthropoda (Crustacea), Annelida, Mollusca, and Echinodermata. They are listed in Table 3-9.

**Table 3-6: Benthic Organisms Associated with Gravel Sediments in the Gulf of Maine Region**

Species	Common Name
<b>Porifera</b>	
<i>Clionia sp.</i>	Sponge
<i>Myxilla sp.</i>	Sponge
<i>Polymastia sp.</i>	Sponge
<b>Coelenterata</b>	
<i>Bougainvillia sp.</i>	Hydroid
<i>Eudendrium sp.</i>	Hydroid
<i>Gersemia sp.</i>	Hydroid
<i>Paragorgia sp.</i>	Hydroid
<i>Sertularia sp.</i>	Hydroid
<i>Tubularia sp.</i>	Hydroid
<b>Crustacea</b>	
<i>Balanus crenatus</i>	Barnacle
<i>B. hameri</i>	Barnacle
<i>Hyas sp.</i>	Toad crab
<b>Annelida</b>	
<i>Chone sp.</i>	Polychaete
<i>Serpula sp.</i>	Polychaete
<i>Spirorbis</i>	Polychaete
<b>Brachiopoda</b>	
<i>Terebratulina sp.</i>	Lampshell

**Table 3-6 (continued): Benthic Organisms Associated with Gravel Sediments in the Gulf of Maine Region**

Species	Common Name
<b>Mollusca</b>	
<i>Anomia sp.</i>	Bivalve
<i>Dendronotus sp.</i>	Nudibranch
<i>Doris sp.</i>	Nudibranch
<i>Modiolus modiolus</i>	Bivalve
<i>Musculus sp.</i>	Bivalve
<i>Neptunea sp.</i>	Gastropod
<i>Placopecten magellanicus</i>	Bivalve
<b>Echinodermata</b>	
<i>Crossaster sp.</i>	Starfish
<i>Ophiacantha sp.</i>	Brittle star
<i>Ophiopholis sp.</i>	Brittle star
<i>Solaster sp.</i>	Starfish
<b>Urochordata</b>	
<i>Amaroucium sp.</i>	Tunicate
<i>Ascidia sp.</i>	Tunicate
<i>Boltenia sp.</i>	Tunicate

Source: Wigley 1968 cited in Earth Tech 1999.

**Table 3-7: Benthic Organisms Associated with Sand Sediments in the Gulf of Maine Region**

Species	Common Name
<b>Crustacea</b>	
<i>Chiridotea sp.</i>	Isopod
<i>Crangon septemspinosus</i>	Shrimp
<i>Leptocuma sp.</i>	Cumacean
<i>Pagurus acadianus</i>	Crab
<b>Annelida</b>	
<i>Clymenella sp.</i>	Polychaete
<i>Goniadella sp.</i>	Polychaete
<i>Ophelia sp.</i>	Polychaete
<b>Mollusca</b>	
<i>Astarte castanea</i>	Bivalve
<i>Lunatia heros</i>	Gastropod
<i>Nassarius trivittatus</i>	Gastropod
<i>Spisula soldissima</i>	Bivalve
<b>Echinodermata</b>	
<i>Echinarachnius parma</i>	Sand dollar

Source: Wigley 1968 cited in Earth Tech 1999.



**Table 3-8: Benthic Organisms Associated with Sand-Silt Sediments in the Gulf of Maine Region**

Species	Common Name
<b>Coelenterata</b>	
<i>Cerianthus sp.</i>	Anemone
<b>Crustacea</b>	
<i>Ampelisca compressa</i>	Amphipod
<i>A. radorum</i>	Amphipod
<i>Diastylis sp.</i>	Cumacean
<i>Dichelopandalus sp.</i>	Shrimp
<i>Edotea sp.</i>	Isopod
<b>Annelida</b>	
<i>Harmothoe sp.</i>	Polychaete
<i>Nephtys sp.</i>	Polychaete
<i>Scalibregma sp.</i>	Polychaete
<b>Mollusca</b>	
<i>Arctica islandica</i>	Ocean quohog
<i>Colus pygmaeus</i>	Gastropod
<i>Crenella sp.</i>	Bivalve
<i>Nucula sp.</i>	Bivalve
<i>Venericardia sp.</i>	Bivalve
<b>Echinodermata</b>	
<i>Amphilmna sp.</i>	Brittle star
<i>Amphiopholis sp.</i>	Brittle star
<i>Thyone scabra</i>	Sea Cucumber

Source: Wigley 1968 cited in Earth Tech 1999.

**Table 3-9: Benthic Organisms Associated with Silt-Clay Sediments in the Gulf of Maine Region**

Species	Common Name
<b>Crustacea</b>	
<i>Calocaris sp.</i>	Shrimp
<i>Geryon sp.</i>	Crab
<i>Haploops tubicola</i>	Amphipod
<i>Munnopsis typica</i>	Isopod
<i>Pandalus sp.</i>	Shrimp
<b>Annelida</b>	
<i>Amphitrite sp.</i>	Polychaete
<i>Leanira sp.</i>	Polychaete
<i>Onuphis sp.</i>	Polychaete
<i>Sternaspis sp.</i>	Polychaete
<b>Mollusca</b>	
<i>Cadulus sp.</i>	Scaphopod
<i>Dentalium sp.</i>	Scaphopod
<i>Modiolaria discors</i>	Bivalve
<i>Scaphander sp.</i>	Gastropod

**Table 3-9 (continued): Benthic Organisms Associated with Silt-Clay Sediments in the Gulf of Maine Region**

Species	Common Name
<b><i>Echinodermata</i></b>	
<i>Amphiura otteri</i>	Brittle star
<i>Briaster fragilis</i>	Heart urchin
<i>Ctenodiscus crispatus</i>	Mud star
<i>Ophiura robusta</i>	Brittle star
<i>O. sarsi</i>	Brittle star
<b><i>Urochordata</i></b>	
<i>Polycarpa fibrosa</i>	Tunicate

Source: Wigley 1968 cited in Earth Tech 1999.

The specific benthic organisms in the area were determined by soil and sediment type. Results of sediment sampling conducted in Massachusetts Bay within or near the boundary of the Stellwagen Bank NMS indicated that diversity of species tended to increase offshore and with greater distance from Stellwagen Bank. There was a trend to a gradual decrease in faunal abundance off shore, which probably was related to increasing depth and decreasing food supply to the bottom. Numerically dominant species from these sets of sampling locations were polychaetes of the phylum Annelida and included: *Spio limicola*, *Prionospio streenstrupi*, *Aricidea quadrilobata*, and *Mediomastus californiensis*. The Spionid *Spio limicola* was the numerically dominant species at most of the sampling locations. The communities appeared fairly stable over time and also appeared to differ from communities observed on Georges Bank. In the Stellwagen Bank area, the species that make up the benthic community may differ from those in adjacent areas because of differences in sediment characteristics and productivity on the bank (USGS/NOAA 1996, cited in Earth Tech 1999).

### ***Mollusks Important to Recreational and Commercial Harvesting***

In the U.S. Exclusive Economic Zone (EEZ), short-finned squid (*Illex illecebrosus*) are targeted by small-mesh otter trawl fisheries near the edge of the continental shelf from June through September. The U.S. fishery is managed by the Mid-Atlantic Fishery Management Council, under the provisions of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. Distribution is influenced strongly by oceanographic factors, and monitoring of the species can present problems. Peak spawning occurs during winter, and individuals from northern areas make a long spawning migration to waters off Cape Hatteras (NOAA 1998, cited in Earth Tech 1999).

Long-finned squid (*Loligo pealei*) are taken off southern New England, with effort directed offshore from October through March and inshore from April through September. The fishery is managed by the Mid-Atlantic Fishery Management Council. The fishery has small-mesh otter trawlers, but landings also are taken from pound nets and traps in spring and summer. Commercial exploitation ranges from Georges Bank to Cape Hatteras. The species migrates seasonally, moving offshore during late fall to overwinter in warmer waters and inshore to spawn in spring and early summer. These squid live for less than a year, grow rapidly and spawn year-round. Those characteristics make them a seasonally dynamic resource (NOAA 1998, cited in Earth Tech 1999).

### ***Invertebrate Species Important to Recreational and Commercial Harvesting***

Several invertebrate species are taken commercially in the Stellwagen Bank area (NOAA 1993, cited in Earth Tech 1999), including:

- American lobster (*Homarus americanus*)
- Northern Shrimp (*Pandalus borealis*)
- Atlantic Surf Clam (*Spisula solidissima*)
- Ocean Quahog (*Artica islandica*)
- Sea Scallop (*Placopecten magellanicus*)

The American lobster offshore fishery is managed under the New England Fishery Management Council's Lobster Fishery Management Plan. The species is abundant from coastal regions to depths of 700 m. Offshore lobsters make well-defined shoalward migrations during the spring. Eggs are carried under the female's abdomen during a 9 to 11 month incubation period. Eggs hatch during late spring or early summer, with the pelagic larvae undergoing four molts before displaying adult characteristics. They then settle to the bottom. The principal fishing gear used for lobsters is the trap. Lobsters also are caught with otter trawls. Recreational harvesting of lobsters occurs along coastal waters (NOAA 1998, cited in Earth Tech 1999).

The northern shrimp fishery is managed by restrictions on gear and imposition of seasonal limits (a 183-day "window" limit from December through May), under the authority of the Atlantic States Marine Fisheries Commission. Northern shrimp are harvested by otter trawl. In the Gulf of Maine, the shrimp inhabit soft, muddy bottoms at approximate depths of 10 m to 300 m. They occur most commonly in the southwestern Gulf of Maine. Spawning and egg extrusion occur in summer. In late fall, females move to coastal waters where eggs hatch during the wintertime. Juveniles remain near shore for more than a year and then migrate offshore as they mature (NOAA 1998, cited in Earth Tech 1999).

In the EEZ, the Atlantic surf clam fishery is managed under the Surf Clam-Ocean Quahog Fishery Management Plan of the Mid-Atlantic Fishery Management Council. The main gear for harvesting surf clams is the hydraulic clam dredge. Commercial quantities of the species are present in southern New England waters. The surf clams are capable of reproduction in their first year of life, although they may not reach full maturity until the second year. Eggs and sperm are shed directly into the water column, and recruitment to the bottom occurs after a three-week larval period (NOAA 1998, cited in Earth Tech 1999).

In the EEZ, the ocean quahog fishery is managed under the Surf Clam-Ocean Quahog Fishery Management Plan of the Mid-Atlantic Fishery Management Council. The main gear for harvesting the ocean quahogs is the hydraulic clam dredge. In the Gulf of Maine, the species is found relatively near shore and is fishable from three to seven miles off shore. Ocean quahogs have a longevity of more than 100 years, with growth slow after age 20. A spawning is reported to occur over an interval from summer through autumn. The pelagic larvae develop slowly and may drift for more than 90 days (NOAA 1998, cited in Earth Tech 1999).

The sea scallop fishery is managed under the Fishery Management Plan for Atlantic Sea Scallops of the New England Fishery Management Council. Management measures can include moratoria on permits, restrictions on days-at-sea, restrictions on gear and crew size, and closing of areas. Sea scallops are harvested year-round, with dredges and otter trawls as the primary fishing gear. North of Cape Cod, the species is scattered in shallow waters, less than 20 m in depth. The principal U.S. commercial fisheries take place in inshore waters of the Gulf of Maine. Sea scallops grow rapidly in the first years of life. Sexual maturity commences at age two. Spawning occurs in late summer and early autumn. The eggs are

buoyant, and larvae remain in the water column for four to six weeks before they settle to the bottom (NOAA 1998, cited in Earth Tech 1999).

### 3.3.3 Marine Mammals

Several species of marine mammals have been reported in the southwestern area of the Gulf of Maine including Stellwagen Bank (NOAA 1993, cited in Earth Tech 1999). Marine mammals regularly migrate seasonally through the region and Stellwagen Bank serves as both a feeding and a nursery area for marine mammals. It has been noted that seven species of cetaceans and one pinniped species use the area regularly (Clapham 1989, cited in Earth Tech 1999). Table 3-10 lists species of marine mammals reported to occur on Stellwagen Bank and in the Stellwagen Bank NMS.

**Table 3-10: Marine Mammals Reported to Occur on Stellwagen Bank**

Common Name	Scientific Name
<b>Endangered Cetaceans</b>	
Humpback whale	<i>Megaptera novaeangliae</i>
Northern right whale	<i>Eubalaena glacialis</i>
Fin whale	<i>Balaenoptera physalus</i>
Sei whale	<i>Balaenoptera borealis</i>
Blue whale	<i>Balaenoptera musculus</i>
<b>Non-endangered Cetaceans</b>	
Minke whale	<i>Balaenoptera acutorostrata</i>
Pilot whale	<i>Globicephala melaena</i>
Orca whale	<i>Orcinus orcus</i>
Atlantic white-sided dolphin	<i>Lagenorhynchus acutus</i>
White-beaked dolphin	<i>Lagenorhynchus albirostris</i>
Harbor porpoise	<i>Phocoena phocoena</i>
Bottlenose dolphin	<i>Tursiops truncatus</i>
Common dolphin	<i>Delphinus delphis</i>
Striped dolphin	<i>Stenella coeruleoalba</i>
Grampus (Risso's) dolphin	<i>Grampus griseus</i>
<b>Pinnipeds</b>	
Harbor seal	<i>Phoca vitulina</i>
Gray seal	<i>Halichoerus grypus</i>

Source: Clapham 1989; Pett and McKay 1990; NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999.

#### **Whales and Dolphins**

Humpback whales are moderately large baleen whales. An adult may range from 35 to 50 feet long and weigh as much as 45 tons. In the Stellwagen Bank area, the endangered humpback whale occurs primarily during the spring (mid-March), summer, and fall. During late fall and early winter, most individuals leave the area and migrate to mating and calving grounds in the West Indies. The annual rate of return to Stellwagen Bank is reported to be high. The whales use Stellwagen Bank primarily for feeding and a principal food source in the area is the sand lance. Data suggest that Stellwagen Bank also is an important nursery ground (Clapham 1989; Mayo 1990; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The endangered northern right whale reaches a maximum length of 50 feet. The general pattern of distribution of the species is in the Stellwagen Bank and Cape Cod area during the late winter and early spring months. The area serves as a nursery ground in the early spring. The whales generally remain in the area until July, when they begin to move farther north. By October, the whales have begun to migrate to the areas in which they winter. Northern right whales feed exclusively on zooplankton, which at Stellwagen Bank consist primarily of calanoid copepods and juvenile euphausiids (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The endangered fin whale is the largest baleen whale sighted in the Stellwagen Bank area. The fin whale is most abundant on Stellwagen Bank in spring, summer, and fall, with some sightings in winter. Fin whales feed on herring and sand lance. Stellwagen Bank appears to be an important nursery ground for the species (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The endangered sei whale is smaller and darker than the fin whale and has been observed feeding on Stellwagen Bank. Sei whales feed on zooplankton, primarily copepods and euphausiids. Since 1986, the number of individuals recorded has been relatively low (Clapham 1989; Pett and McKay 1990, cited in Earth Tech 1999).

The endangered blue whale is the largest of all the whales. It has been reported three times on Stellwagen Bank. When observed, the species was feeding, probably on euphausiids. Blue whales also may feed on copepods, squid, and fish species (Clapham 1989; Pett and McKay 1990, cited in Earth Tech 1999).

The minke whale is the smallest baleen whale in the North Atlantic. It commonly is seen in the Stellwagen Bank area during spring, summer, and fall (Clapham 1989, cited in Earth Tech 1999). The species has been seen in the northern area of Stellwagen Bank and southern Jeffrey's Ledge from March until November. Minke whales feed primarily on schooling fish species and euphausiids (Pett and McKay 1990, cited in Earth Tech 1999).

The pilot whale, distinguished by the species' large bulbous head, generally has been observed along the shelf edge (100 to 1,000 m contour), but also may be observed in the central and northern Georges Bank, the Great South Channel, and the Gulf of Maine region between May and October. Pilot whales feed on squid, with invertebrates and fish species as alternatives (Pett and McKay 1990, cited in Earth Tech 1999).

The orca whale has been reported in the southwestern Gulf of Maine from mid-July through September. The whales also are known to overwinter in the Gulf of Maine. They have been reported on Jeffrey's Ledge southward to Stellwagen Bank. The species is an opportunistic feeder that eats various fish species, including bluefin tuna, and even seabirds and other cetaceans. In general, orcas are considered to be uncommon in the Gulf of Maine and infrequent visitors to Stellwagen Bank (NOAA 1993, USGS/NOAA 1996, cited in Earth Tech 1999).

The atlantic white-sided dolphin is common on Stellwagen Bank during spring and fall, from July through September. The species' primary activity in the Stellwagen Bank area appears to be feeding. The dolphins feed on herring, squid, and sand lance (Clapham 1989; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The white-beaked dolphin reaches a maximum length of 10 feet. White-beaked dolphin are infrequent visitors to Stellwagen Bank. In the southern Gulf of Maine, the species occurs from April through November, with more spring sightings reported at Stellwagen Bank. The dolphins forage on squid and fish species (Clapham 1989; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

Harbor porpoises are the smallest cetaceans observed on Stellwagen Bank. They are common in the Stellwagen Bank region between April and May, with numbers decreasing by June. During summer, the species is more abundant in the northern Gulf of Maine and somewhat absent from the southwestern part, including Stellwagen Bank. It is thought that they move southward along the coast in the fall. Harbor porpoises feed primarily on herring and silver hake (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The bottlenose dolphin usually occurs in the Gulf of Maine during late summer and fall. Occurrences of this dolphin in the Stellwagen Bank region are considered very rare, and it does not appear that the species uses Stellwagen Bank to any great extent (Clapham 1989; USGS/NOAA 1996, cited in Earth Tech 1999).

The common dolphin is recognized by an hourglass-shaped pattern on both sides of the body. Very few sightings have been recorded at the Stellwagen Bank. This species is an opportunistic forager (Clapham 1989; USGS/NOAA 1996, cited in Earth Tech 1999).

The striped dolphin is seen only occasionally in the Gulf of Maine. Striped dolphins feed primarily on fish species and squid (NOAA 1993, cited in Earth Tech 1999).

The Grampus (Risso's) dolphin has been observed infrequently in the Stellwagen Bank area during the summer and fall. The species is thought to feed exclusively on squid (NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999).

### **Seals**

Harbor seals occur in southern New England, primarily from late September through May. They often are observed on Stellwagen Bank. After May, they move northward toward the coast of Maine. In general, harbor seals are opportunistic feeders that forage on fish species (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

Gray seals have been observed with some frequency in the area in winter and early spring, and periodic sightings have been noted in the summer, as well. Gray seals feed mostly on fish species but will forage for invertebrates (Clapham 1989; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

### **3.3.4 Marine Reptiles**

Four species of marine turtles have been reported in Gulf of Maine waters, although only two of those species occur with any regularity (NOAA 1993, cited in Earth Tech 1999). The species are the Atlantic or Kemp's ridley turtle (*Lepidochelys kempi*); the Leatherback turtle (*Dermochelys oriacea*); the Loggerhead turtle (*Caretta*); and the Green sea turtle (*Chelonia mydas*).

Massachusetts is the northern tolerance limit for the federally-listed threatened loggerhead, with temperature the limiting factor, so they are not regular visitors to the area. Similarly, the federally-listed threatened green sea turtle is normally found in warmer waters, and only rarely in summertime within Cape Cod Bay.

The federally-listed endangered Atlantic ridley turtle occurs as juveniles in summer in waters off Massachusetts, after hatching in Mexico and traveling the Gulf Stream. Southern New England waters are important feeding grounds for the species (NOAA 1993, cited in Earth Tech 1999), although, according to some scientists, they may be only accidental visitors to the area, having been carried there by the currents of the Gulf Stream (Pett and McKay 1990, cited in Earth Tech 1999).

The federally-listed endangered leatherback turtle is a summer visitor in the Gulf of Maine, where it comes to feed on nektonic jellyfish and combjellies. Adults are observed primarily individually in late summer (NOAA 1993, cited in Earth Tech 1999). In fall, the leatherback moves farther offshore and migrates south. The leatherback is susceptible to human interference because the morphology and size of the species prevents the turtle from swimming backward. They therefore can become trapped in obstructions, such as fishing nets and lobster pot lines, and sometimes they collide with boats.

### 3.3.5 Marine Birds

More than 40 species of seabirds are commonly found in the southwestern Gulf of Maine in the vicinity of the project area (see Appendix F). In particular, these birds tend to frequent the vicinity of the Stellwagen Bank because of its nutrient-rich waters, which support the birds' diet of zooplankton and fish. The birds spend from 50 to 90 percent of their life cycles at sea, returning to land primarily to breed. With the exception of one species, Leach's storm petrel, the seabirds are either migrants or nonbreeding residents of the Stellwagen Bank area (Earth Tech 1999).

In any season, only 10 species account for more than 95 percent of the birds sighted (Pett and McKay 1990, cited in Earth Tech 1999). Table 3-11 shows the seasonal distributions and relative abundances of the dominant species. The winter months are dominated by migratory kittiwakes and overwintering razorbills. Resident herring gulls and great black-backed gulls also are dominant. All feed primarily on fish species. The seabird populations are the least abundant in spring, although the gulls identified above are as abundant in that season as in winter.

**Table 3-11: Common Seabird Species by Season at Stellwagen Bank**

Species	Winter	Spring	Summer	Fall
Northern fulmar	6 [0.17%]	154 [6.00%]		
Greater shearwater	2 [0.05%]		4,165 [10.72%]	25,684 [39.92%]
Sooty shearwater		158 [6.15%]	1,819 [4.68%]	
Manx shearwater			345 [0.88%]	
Wilson's storm petrel		780 [30.40%]	24,213 [62.35%]	2,522 [3.92%]
Northern gannet	237 [6.83%]	438 [17.07%]	87 [0.22%]	6,786 [10.54%]
Common eider	21 [0.60%]			880 [1.36%]
Surf scoter				500 [0.77%]
Oldsquaw	13 [0.37%]			
Red-necked phalarope		91 [3.54%]		740 [1.15%]
Parasitic jaeger		20 [0.77%]	92 [0.23%]	
Herring gull	162 [4.67%]	377 [14.69%]	915 [2.35%]	1,028 [1.59%]
<b>Great black-backed gull</b>	340 [9.80%]	268 [10.44%]	336 [0.86%]	
Laughing gull			1,028 [2.64%]	1,025 [1.59%]
Bonaparte's gull	18 [0.51%]			
Black-legged kittiwake	1,615 [46.56%]	158 [6.15%]		6,113 [9.50%]
Common tern			5,688 [14.64%]	16,042 [24.93%]
Razorbill	999 [28.80%]	13 [0.50%]		
<b>Season Total</b>	<b>3,413 [98.41%]</b>	<b>2,457 [95.79%]</b>	<b>38,688 [99.63%]</b>	<b>61,320 [95.32%]</b>

Source: For each species and season, the number of seabirds and percentage of all seabirds seen at Stellwagen Bank is provided. Data compiled from records of Manomet Bird Observatory 1979-1990, as reported in Pett and McKay, (1990), cited in Earth Tech 1999.



Kittiwakes, shearwaters, petrels, gannets, phalaropes, and fulmars all are present at Stellwagen Bank during their northern migrations. Those species feed primarily on zooplankton. In summer, petrels are very abundant, coincident with the zooplankton peak in late spring. Terns and shearwaters also become more abundant in late spring, and feed on fish, squid, and crustaceans. Various gulls are abundant in summer. In the fall, shearwaters and kittiwakes again are abundant because of the southern migration, along with terns and other species that migrate through the area (Earth Tech 1999).

### 3.3.6 Plankton

Both phytoplankton and zooplankton are found in the vicinity of the Stellwagen Bank NMS. Both are discussed below.

#### *Phytoplankton*

A diverse phytoplankton community dominated by several species of diatoms forms the basis of the food chain for many of the significant marine resources found in the Stellwagen Bank area and in the Gulf of Maine in general. Although little specific information about phytoplankton populations in the Stellwagen Bank area is available, table 3-12 lists the major species of phytoplankton found in the Gulf of Maine and Massachusetts Bay (NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999). It can be expected that the population over Stellwagen Bank is even more abundant than that of surrounding waters because of the upwelling of nutrients in the area of the bank. The highest concentrations of phytoplankton are found between December and early April and again in August. Population densities at other times of year are limited because of light and nutrient conditions. The major species of phytoplankton found in winter include *Coscinodiscus* and *Ceratium*, followed by blooms of *Thalassiosira* and *Chaetoceros* in the spring, when the critical depth for photosynthesis deepens with increasing temperature and light levels and more nutrients are available in surface waters. There is a smaller peak in phytoplankton levels in late summer and early fall (Earth Tech 1999).

**Table 3-12: Major Species of Phytoplankton Found in the Gulf of Maine and Massachusetts Bay Area**

Species Name	
<i>Amphidinium crassum</i>	<i>Leptocylindrus danicus</i>
<i>Betonula confervaceae</i>	<i>Leptocylindrus minimus</i>
<i>Ceratium longipipes</i>	<i>Porosira glacialis</i>
<i>Chaetoceros sp.</i>	<i>Rhizosolenia. faeoveuse</i>
<i>Coscinodiscus sp.</i>	<i>Rhizosolenia fragillissima</i>
<i>Cylindrotheca closterium</i>	<i>Skeletonema costatum</i>
<i>Guinardia flaccida</i>	<i>Thalassiosira sp.</i>

Source: NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999.

#### *Zooplankton*

A diverse zooplankton community comprising approximately 160 species, but dominated by three or four species of calanoid copepods, occurs in the Gulf of Maine and Massachusetts Bay area (NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999). Information about the specific composition of zooplankton populations in the Stellwagen Bank area is lacking. It is likely that the shelf community differs from those of surrounding waters, since water depth and the interrelated factors of temperature, circulation, and

salinity are key factors in the distribution of zooplankton (Thurman 1988, cited in Earth Tech 1999). Massachusetts Bay is a highly productive zooplankton area because the counterclockwise currents in the Gulf of Maine bring zooplankton into the bay. Because both meroplankton and holoplankton are important components of the zooplankton population, the area is a critical habitat for the early life stages and food of commercial fishery species (Pett and McKay 1990, cited in Earth Tech 1999).

Table 3-13 presents the major species of zooplankton found in the Gulf of Maine and Massachusetts Bay (NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999). Unlike the case of phytoplankton, there is not a great deal of seasonal variation in the composition of species, although densities of species do change. The largest increase in zooplankton populations begins in March, coincident with the period of greatest abundance of phytoplankton, and peaks in May. The decrease in population densities during the summer is the result of both natural mortality and predation. There may be another smaller increase in zooplankton populations in fall, followed by another decrease in the winter months (Pett and McKay 1990, cited in Earth Tech 1999). Distribution of zooplankton also varies with depth, especially during summer stratification, which may be less pronounced in waters over the bank. Surface waters to 25 m are dominated by smaller copepods and the younger life stages of large copepod species; fish species eggs and larvae; and, at night, migrating copepods, euphausiids, and chaetognaths. At mid-depths of 25 to 100 m, the copepod *Calanus* dominates. At depths greater than 100 m, giant copepods, chaetognaths, and euphausiids are found (Pett and McKay 1990, cited in Earth Tech 1999).

**Table 3-13: Major Species of Zooplankton Found in the Gulf of Maine and Massachusetts Bay Area**

Species Group	Species
Amphipod	<i>Euthemisto sp.</i>
Chaetognath	<i>Eukronia sp.</i>
Chaetognath	<i>Sagitta elegans</i>
Chaetognath	<i>Sagitta lyra</i>
Cnidaria	<i>Aurelia sp.</i>
Cnidaria	<i>Cyanea sp.</i>
Copepod	<i>Acartia sp.</i>
Copepod	<i>Anomalocera sp.</i>
Copepod	<i>Calanus finmarchicus</i>
Copepod	<i>Centropages typicus</i>
Copepod	<i>Euchaeta norvegica</i>
Copepod	<i>Metridia lucens</i>
Copepod	<i>Pseudocalanus minutus</i>
Copepod	<i>Temora longicornus</i>
Copepoda	<i>Acartia sp.</i>
Copepoda	<i>Calanus finmarchicus</i>
Copepoda	<i>Centropages typicus</i>
Copepoda	<i>Metridia lucens</i>
Ctenophore	<i>Pleurobrachia pileus</i>
Copepoda	<i>Pseudocalanus minutus</i>
Copepoda	<i>Temora longicornus</i>
Decapod shrimp	<i>Pasiphaea sp.</i>
Euphausiid	<i>Meganyctiphanes norvegica</i>
Euphausiid	<i>Thysanoessa sp.</i>
Pteropod mollusc	<i>Limacina retroversa</i>

Source: NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999.

### 3.4 SOCIOECONOMIC RESOURCES

The socioeconomic resources of the region include commercial fishing, commercial shipping and navigation, whale watching, recreational fishing, bird watching, boating, and diving. Each resource is discussed in more detail below.

#### *Commercial Fishing*

Commercial fishing, including groundfish, pelagic, and invertebrate fisheries, both historically and currently is the most economically important human activity in the productive waters of the Gulf of Maine, including Massachusetts Bay. Stellwagen Bank is an area of particular concentration for commercial fisheries, with more than 280 commercial vessels active in the area in 1990 (NOAA 1993, cited in Earth Tech 1999). Fish species of commercial importance are grouped in four categories: groundfish, pelagics, other finfish, and invertebrates. Table 3-14 shows the important commercial species in each of those groups, as well as the commercial value of landings of those species, according to 1990 statistics. Although most fish species are taken year-round, peak fishing intervals occur for most regulated species (see Table 3-15). Commercial bluefin tuna fishing represented 50 percent of the economic value of all fisheries in the Stellwagen Bank area in 1990, and the majority of the U.S. catch of this species is landed in Massachusetts coastal waters. After bluefin, the most valuable species in the Stellwagen area in terms of dollars are cod, yellowtail flounder, and pollock; in terms of poundage, dogfish, whiting, cod, and pollock are important (USGS/NOAA 1996, cited in Earth Tech 1999).

While more recent statistics were not available on the Stellwagen Bank area alone, information about commercial catches from Cape Hatteras to Nova Scotia indicate that during the period from 1994 to 1997, commercial value peaked in 1995 and in 1997 had increased by 37 million dollars for the entire region, representing only a 4 percent increase (NOAA 1998, cited in Earth Tech 1999). Therefore, the 1990 statistics are probably within 10 percent of current commercial value. In 1997, in the northeast as a whole, from Cape Hatteras to Nova Scotia, lobster was the number one revenue generator, followed by sea scallops, and along with squid and shrimp represented 31 percent of the catch since 1994. Principal pelagics represented 30 percent of the catch, and groundfish and flounder represented 36 percent of the catch (NOAA 1998, cited in Earth Tech 1999).

The fish species taken commercially are managed by the New England Fishery Management Council or the Mid-Atlantic Fishery Management Council through a number of fisheries management plans, including plans for the American lobster, the Atlantic sea scallop, the Atlantic salmon, the Atlantic mackerel, the squid, the butterfish, the Atlantic surf clam, the ocean quahog, the Atlantic bluefish, and the summer flounder. In addition, minimum catch sizes have been set for other species. Fishing is controlled by a complex set of regulations limiting entry and open access through limits on the number of permits issued and catch quotas. Changes in commercial fisheries that have taken place since the 1990 statistics were gathered include the implementation of fisheries management plans that restrict harvests of many species; changes in monitoring and reporting requirements; changes in mesh size; a 50 percent reduction in days at sea to reduce catch; permit and vessel buybacks; and the establishment of several closure areas, including the Massachusetts Bay and Midcoast closure areas, which include part of the Stellwagen Bank NMS (USGS/NOAA 1996; SSI 1999, cited in Earth Tech 1999). See Figure 3-3 for fishing hazards and restricted fishing areas, including the Jeffery's Juvenile area, which is restricted as a spawning area.

**Table 3-14: Fish Species of Commercial Importance in Stellwagen Bank Area and Commercial Value of 1990 Landings**

Groundfish Species (\$5,979,134)	Pelagic Fish (\$7,964,716)
Atlantic cod, <i>Gadus morhua</i> Haddock, <i>Melanogrammus aeglefinus</i> Redfish (ocean perch, rosefish), <i>Sebastes spp.</i> Silver hake (whiting), <i>Merluccius bilinearis</i> Red hake (squirrel hake), <i>Urophycis chuss</i> Pollack, <i>Pollachius virens</i> Yellowtail flounder, <i>Pleuronectes ferrugineus</i> Summer flounder, <i>Paralichthys dentatus</i> America plaice (dab), <i>Hippoglossoides platessoides</i> Witch flounder, <i>Glyptocephalus cynoglossus</i> Winter flounder, <i>Pleuronectes americanus</i> Scup (porgy), <i>Stenotomus chrysops</i> Ocean pout (muttonfish), <i>Macozoarces americanus</i> White hake, <i>Urophycis tenuis</i> Cusk, <i>Brosme</i> Atlantic wolffish, <i>Anarhichas lupus</i> Fourspot flounder, <i>Paralichthys oblongus</i> Windowpane flounder (Sand Dab), <i>Scophthalmus aquosus</i> Greenland (Atlantic) halibut, <i>Reinhardtius hippoglossoides</i> King whiting (kingfish), <i>Menticirrhus saxatilis</i> Sculpins, <i>Myoxocephalus octodecimspinosus</i> Sea sturgeon, <i>Acipenser sturio</i> Tautog (blackfish), <i>Tautoga onitis</i> Sand eel (sand lance), <i>Ammodytes americanus</i> American eel, <i>Anguilla rostrata</i> Black sea bass, <i>Centropristis striata</i>	Atlantic herring, <i>Clupea harengus</i> Atlantic mackerel, <i>Scomber scombrus</i> Butterfish, <i>Peprilus triacanthus</i> Bluefish (snapper), <i>Pomatomus saltatrix</i> Deep sea angler, <i>Ceratias holbolli</i> Menhaden (pogy), <i>Brevoortia tyrannus</i> Bluefin tuna, <i>Thunnus thynnus</i> Capelin, <i>Mallotus villosus</i>
	Other Finfish (\$821,988)
	American shad, <i>Alosa sapidissima</i> Striped bass (rockfish), <i>Morone saxatilis</i> Spiny dogfish, <i>Squalus acanthias</i> Skates, <i>Rajidae spp.</i> Mako shark, <i>Isurus oxyrinchus</i> Atlantic silverside (Capelin), <i>Menidia</i>
	Invertebrates (\$555,582)
	Short-finned squid, <i>Illex illecebrosus</i> Long-finned squid, <i>Loligo pealei</i> American lobster, <i>Homarus americanus</i> Northern shrimp (pink shrimp), <i>Pandalus borealis</i> Surf clam, <i>Spisula solidissima</i> Ocean quahog, <i>Artica islandica</i> Sea scallop, <i>Placopecten magellanicus</i>

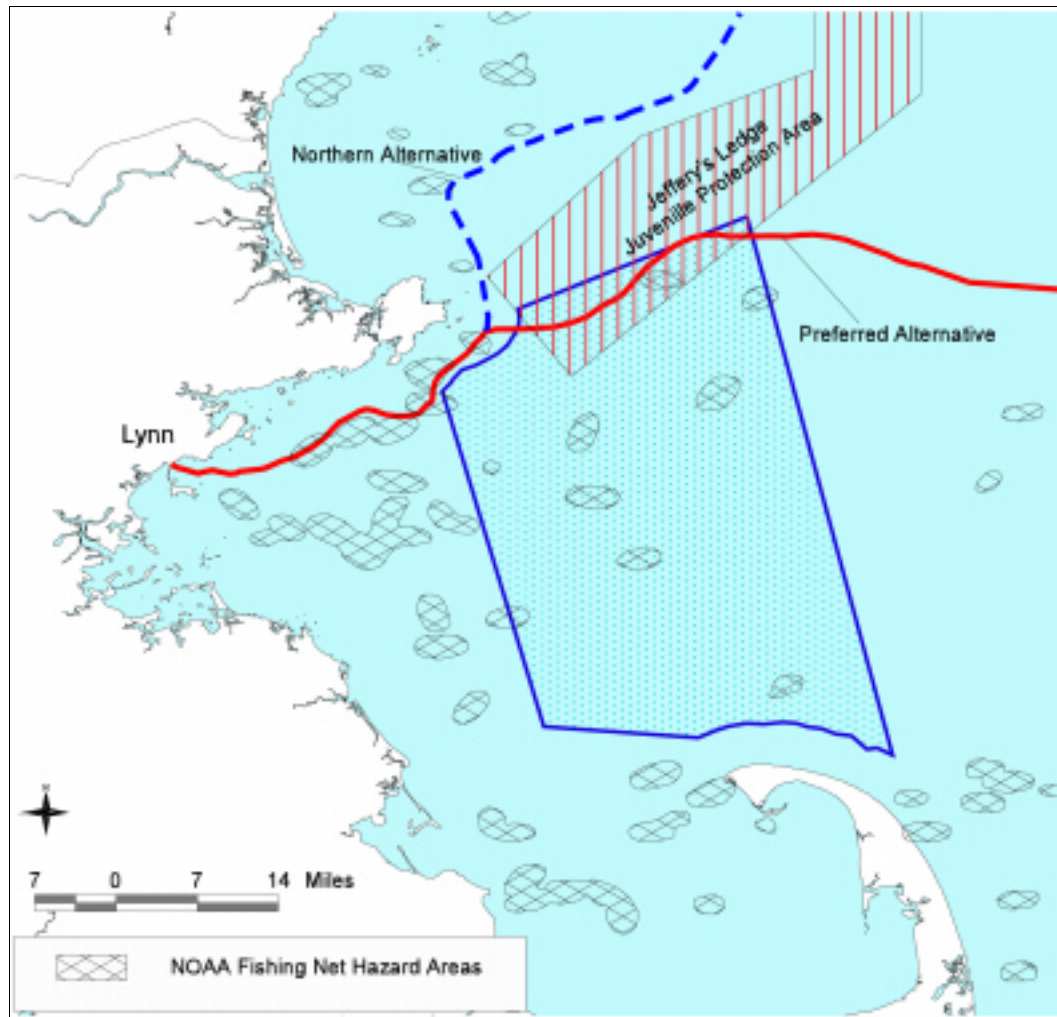
Source: NOAA 1993, cited in Earth Tech 1999.

**Table 3-15: Peak Seasonal Fishing Intervals for Major Regulated Species in the Stellwagen Bank Area**

January through March		April through June	
Winter flounder		Winter flounder	Witch flounder
Atlantic herring		Redfish	Atlantic cod
Northern shrimp		American plaice	
July through September		October through December	
Bluefin tuna	Redfish	Silver hake	White hake
Red hake	American plaice	Red hake	Winter flounder
Summer flounder	Witch flounder	Pollack	Atlantic herring
Striped bass	Bluefish	Atlantic mackerel	American lobster
		Butterfish	Sea scallop

Source: NOAA 1993, cited in Earth Tech 1999.

**Figure 3-3: Massachusetts Bay Fishing Hazards and Restricted Fishing Areas (USGS 2000)**



The major types of mobile commercial fishing gear used include otter trawls; purse and Scottish seines; and, occasionally, scallop and clam dredges. Static fishing gear includes sink gillnets, lobster pots, and longlines. With the exception of purse seines, which are set to catch pelagic fish species at or near the ocean surface, the gear can affect both ocean waters and the seabed. Otter trawls, the most common fishing gear, and Scottish seines are drawn along the seabed to catch bottom-dwelling fish species. Scallop and clam dredges harvest shellfish on or in the sea bed. Tub trawls are anchored or can drift in the water column and are used to catch groundfish. Sink gillnets can be set at any level within the water column. Hook and line are used for both groundfish and tuna. Rigid fish and lobster traps are used to harvest groundfish, lobsters, and crabs. In terms of commercial value, from 1994 to 1996 for the northeast fishery, pots and traps provided the largest amount of revenue, followed by bottom otter trawls and sea scallop dredges (NOAA 1998, cited in Earth Tech 1999).

### ***Commercial Shipping and Navigation***

Commercial shipping is also an important industry in the area. Heavily used vessel traffic lanes carry more than 2,700 commercial vessels through the Massachusetts Bay area to Boston each year (NOAA 1993, cited in Earth Tech 1999). There is an established Vessel Traffic Separation Scheme for boat traffic. About half the vessels carry liquid petroleum products, with the rest carrying bulk materials and automobiles. In addition, a small number of cruise ships and research and military vessels traverse the Gulf of Maine to Boston Harbor and Cape Cod. Vessel traffic exhibits no marked seasonal pattern.

### ***Whale-Watching***

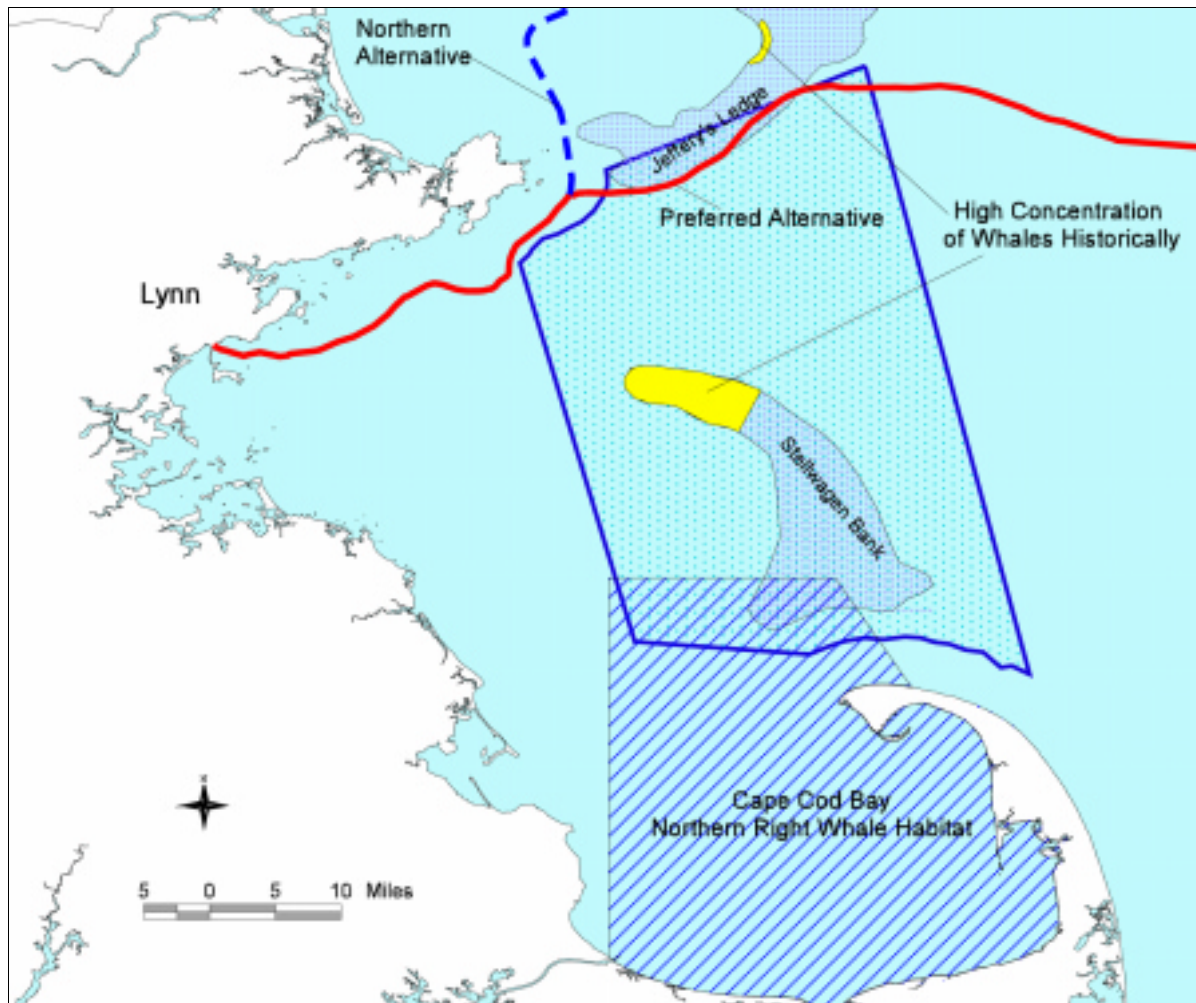
The whale-watching industry has grown steadily since its beginnings in Massachusetts in the late 1970s. Whale-watching trips provide recreational and educational opportunities and also can provide opportunities for marine bird watching (Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999). The Massachusetts area, from Gloucester to Provincetown, has been referred to as the “golden crescent” of whale watching (Rumage 1990, cited in Earth Tech 1999). The New England Whale-Watching Association has estimated that 48 percent of all whale-watching in the United States and 39 percent of all whale-watching activity worldwide take place in New England (NOAA 1996, cited in Earth Tech 1999). See Figure 3-4 for major whale-watching locations in and around Massachusetts Bay.

Whale-watching operations in the area are focused primarily on Stellwagen Bank and Jeffrey’s Ledge. Gloucester has four operations, Boston five, Salem one, Plymouth one, Barnstable one, and Provincetown four. Some operations in Gloucester and Provincetown have several boats. Farther north, Newburyport, Massachusetts; Portsmouth and Rye Harbor, New Hampshire; and Bar Harbor, Maine have one or more whale-watching operations (NOAA 1996, cited in Earth Tech 1999).

The whale-watching season usually begins in April, with about one trip daily through June. During those months, school groups make up the principal market. July and August make up the peak season, usually with two trips per boat per day. During that peak season, tourists are the principal market. During September and October, until Columbus Day, a daily trip on weekends is typical. In general, seasonal demand and varying weather conditions affect the number of trips (NOAA 1996, cited in Earth Tech 1999).

In addition to the commercial whale-watching vessels, numerous small, private boats follow the commercial boats to the whale-watching areas. The smaller boats are referred to as the “mosquito fleet” (NOAA 1996, cited in Earth Tech 1999). Whale-watching boats can carry from 40 passengers (a 50-foot boat) to almost 400 passengers (a 140-foot boat) and make from one to three trips per day. The industry, therefore, has a significant effect on the area’s economy. Revenues from commercial whale-watching were more than \$20 million dollars for the two-year period from 1985 to 1986 and were more than \$17 million in 1990 (NOAA 1993, cited in Earth Tech 1999).



**Figure 3-4: Massachusetts Bay Whale-Watching Locations (USGS 2000)**

### ***Recreational Fishing***

Before the mid-1970s, most recreational fishing was conducted in the nearshore waters inside the three-mile limit (U.S. territorial waters). After that time, groundfish declined in the nearshore area, and the market for bluefin tuna opened in Japan. Those two factors influenced an increase in the amount of recreational fishing taking place on Stellwagen Bank (NOAA 1993, cited in Earth Tech 1999).

Recreational fishing activities, including sport fishing, on Stellwagen Bank can be best described by the type of fishing vessels used. Those vessels include party boats, charter boats, and private rental boats. Targeted sport fishing species and their seasons include baitfish and sport fish (late May to September), groundfish (March to June), and tuna (June to early November). Recreational and tourism activity in the Stellwagen Bank area also includes operations of privately owned boats used for fishing or whale-watching and bird watching (Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999). Data from 1987 through 1989 on recreational fishing beyond the three-mile limit indicate that the following species are those most commonly caught (NOAA 1993, cited in Earth Tech 1999):



- Scup (*Stenotomus chrysops*)
- Bluefish (*Pomatomus saltatrix*)
- Atlantic Cod (*Gadus morhua*)
- Winter Flounder (*Pleuronectes americanus*)
- Atlantic Mackerel (*Scomber scombrus*)
- Pollock (*Pollachius virens*)
- Tautog (*Tautoga onitis*)
- Dogfish Sharks (*Squalus acanthias*)
- Summer Flounder (*Paralichthys dentatus*)

Sport fishing is also a major commercial operation in the area. Statewide, the industry was valued at \$9.5 million in 1987 from charter boats and \$167 million from private boat rentals. Recreational fishermen and tourists also spend significant tourism dollars that bolster the area's economy (Earth Tech 1999).

### ***Bird Watching***

Marine bird watching is a recreational activity in the Stellwagen Bank area that can be experienced in conjunction with whale-watching trips or sport fishing trips or carried out by interested individuals in privately owned boats. The ecotourism industry offers such options as the Center for Oceanic Research and Education's trips offshore during which bird experts assist with sightings and offer expertise in the identification of numerous species of birds. Cold-water seabirds of the Gulf of Maine and, at times, subtropical and Gulf Stream species can be observed (NOAA 1996; CORE 1999, cited in Earth Tech 1999).

### ***Boating***

Recreational boating is very popular in the Stellwagen Bank area, as well as in the area between the bank and the Cape Ann and Boston region. The area has numerous marinas at which a variety of recreational boats, both power and sail, are moored seasonally or at which transient moorings or berths are available. The proximity of the Stellwagen Bank to those areas allows day trips or through passage to popular destinations at the Isles of Shoals, New Hampshire and Maine; coastal New Hampshire; and Maine (Earth Tech 1999).

### ***Diving***

Recreational diving occurs infrequently in the Stellwagen Bank area. Most diving in the offshore area is anticipated to occur in the vicinity of reported wrecks (Earth Tech 1999).

### 3.5 CULTURAL AND HISTORICAL RESOURCES

During the past five centuries, boats and ships have been used over the project area for a variety of reasons, including exploration, transportation, fishing, and warfare. Historical vessel traffic occurred over the Stellwagen Bank area in three basic patterns: vessel traffic to and from Massachusetts Bay ports; increased vessel traffic bound for ports beyond Massachusetts Bay after the opening of the Cape Cod Canal in 1914; and vessel traffic related to the Massachusetts Bay fishing fleet (USGS/NOAA 1996, cited in Earth Tech 1999).

Over time, some of the vessels were lost, creating unique sites that would be considered historically and archaeologically significant by federal and state standards, since they may contain information about America's past that cannot be found elsewhere (Riess 2000). The National Ocean Service's Automated Wreck and Obstruction Information System has placed numerous shipwrecks, mainly fishing vessels, in the area. Records of the Historic Maritime Group of New England also have identified possible shipwreck areas in the vicinity of the Stellwagen Bank NMS. An aircraft crash site also may be located in the area (Mastone 1990; NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999).

An archaeological survey (magnetometer survey) was conducted in February 2000 to determine whether any cultural or historical resources are located in the vicinity of the proposed cable route. The survey, prepared by Dr. Warren Riess of the Darling Marine Center, University of Maine, included both a study of historical records and an analysis of data from remote-sensing searches.

The study of historical records included a search for information about lost vessels in published and unpublished secondary sources and limited primary archival material. It included the entire sea floor in the northern section of the Stellwagen Bank NMS within one mile of the planned cable route, and addressed resources more than 50 years old. Table 3-16 presents the results of the study of historical records and secondary sources (Riess 2000).

**Table 3-16: Table of Shipwrecks Located During Background Research**

Name	Date	Location	Wreck Notes
<i>Erfprins</i>	11/25/1783	24 mi off Cape Cod	Foundered
<i>Shylock</i>	12/1/1860	35 mi east of Cape Ann	Abandoned
<i>Frank A. Palmer</i>	12/17/1902	Thatchers Island, Rockport	Collided with <i>Louise B. Crary</i>
<i>Louise B. Crary</i>	12/17/1902	Northern edge of Stellwagen Bank NMS	Collided with <i>Frank A. Palmer</i>
<i>Nataile Hammond</i>	7/29/1937	Northeast sector of Stellwagen Bank	All crew saved
<i>Restless</i>	10/4/1942	Stellwagen Bank	Burned
<i>Unknown</i>	1/1/1949	Northern Stellwagen Bank NMS	
<i>Alden</i>	2/22/1957	Stellwagen Bank area – 8 mi off Thatcher's Buoy	Fire

Source: Riess 2000.

The remote-sensing component of the archaeological survey included the examination of a 200-foot-wide corridor centered on the proposed cable route. Several instruments, including a navigation system, a magnetometer, side-scan sonar, and a bathymeter were used in the effort. The data collected were examined in several different ways to identify possible magnetic anomalies and sonar targets. No sites were found within 100 feet of either side of the centerline of the proposed cable route throughout the Stellwagen Bank NMS.

The survey examined only the Preferred Alternative route through the Stellwagen Bank NMS and did not include a detailed examination of the Northern Alternative route. Therefore, only data from secondary sources were examined for the Northern Alternative. On the basis of such data, it was determined that known and potential cultural and historical resources occur in proximity to the Northern Alternative route. The Northern Alternative crosses areas that can serve as navigation routes to and from the city of Portland, Maine. Navigation charts indicate wreck locations in the vicinity of Jeffrey's Ledge and approach areas to the ledge. Natural and man-made seafloor obstructions along that route and wrecks in proximity to it were identified from Admiralty charts (Earth Tech 1999).

Even though no recorded prehistoric cultural resources, sites, or artifacts have been identified to date, the potential that they exist should be considered. Periodic recovery of remains such as parts of skeletons of mammoths and mastodons by fishermen does indicate that environmental conditions once supported such megafauna (NOAA 1993, cited in Earth Tech 1999).